Abstracts

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Gene engineering of woody plants, F. SAKAI: *Wood Research and Technical Notes*, No. **31**, 1–10 (1995) (Review in Japanese).

Recent advances in gene engineering of woody plants were reviewed.

Biotechnology in woody plants, F. SAKAI: *Wood Preservation*, Vol. **21**, No. **6**, 14–22 (1995) (Review in Japanese).

The application of biotechnology to woody plant improvement was introduced.

Induction of a cytochrome P450 by methyl jasmonate in soybean suspension-cultured cells, G. SUZUKI, H. OHTA, T. KATO, S. IGARASHI, F. SAKAI, D. SHIBATA, A. TAKANO, T. MASUDA, Y. SHIOI and K. TAKAMIYA: *FEBS Letters*, **383**, 83–86 (1996).

We isolated a cDNA encoding cytochrome P450 from soybean suspention-cultured cells that had been treated with methyl jasmonate (MeJA). The amino acid sequence of the gene product had 30–40% identity with those of other plant P450s. The protein contained the heme-binding domain which is highly conserved among plant P450s. The transcription of the cytochrome P450 gene in soybean cells was induced by 30 μM MeJA even in the presence of cycloheximide, and reached to a maximum level 6 h after MeJA-treatment. This is a novel type of plant cytochrome P450 gene whose transcription is induced by MeJA even without protein synthesis.

Characterization of xyloglucan endotransglycosylation. T. TAKEDA, Y. MITSUISHI, F. SAKAI and T. HAYASHI: *Wood Research*, **82**, 14–16 (1995).

Poplar xyloglucan endotransglycosylase has been characterized biochemically.

Cloning and sequencing of cDNA for poplar endo-1, 4-β-Glucanase. S. NAKAMURA, H. MORI, F. SAKAI and HAYASHI: *Plant Cell Physiol.*, **36**, 1229–1235 (1995).

A cDNA for poplar endo-1, 4-β-glucanase was cloned by use of a synthetic oligonucleotide as probe. The probe was designed on the basis of the N-terminal amino acid sequence of the β-glucanase from suspension-cultured poplar cells (*Populus alba* L.), and by complete nucleotide sequence of the cDNA was determined. The 1,614-bp cDNA contained an open reading frame of 1,482 base pairs, encoding 494 amino acids. Removal of a putative signal sequence from the deduced amino acid sequence of the polypeptide yielded a mature protein of 467 amino acids. Comparison of deduced amino acid sequences revealed that the poplar endo-1, 4-β-glucanase was 80% and 70% identity to avocado fruit and bean abscission endo-1, 4-β-glucanases, respectively. Hydropathy plot analysis of the deduced amino acid sequence suggests that poplar endo-1, 4-β-glucanase belongs to family E in terms of the cellulose catalytic domain, and avocado fruit and abscission bean endo-1,

4-β-glucanases also belong to this family. 2, 4-D markedly increased the level of the endo-1, 4-β-glucanase mRNA in cultured cells, while GA_3, benzyladenine and abscisic acid each repressed transcription of this mRNA. The transcript was also detected in the roots and stems of intact plants, although the level of mRNA was much lower in intact tissues than in cultured cells. Genomic Southern analysis indicated that a small family of gene for endo-1, 4-β-glucanase exists in poplar.

Purification and properties of wall-bound endo-1, 4-β-glucanase from suspension-cultured poplar cells. Y. OHMIYA, T. TAKEDA, S. NAKAMURA, F. SAKAI and T. HAYASHI: *Plant Cell Physiol.*, **36**, 607–614 (1995).

A wall-bound endo-1, 4-β-glucanase (EC 3.2.1.4) was obtained from a preparation of the cell walls of suspension-cultured poplar cells and purified to electrophoretic homogeneity by cation-exchange, hydrophobic, and gel-filtration chromatography. The molecular mass was estimated to be 47 kDa by SDS-PAGE and 48 kDa by gel filtration on Superdex 200 pg. The isoelectric point (pI) was 5.6. The purified enzyme catalyzed the endo-hydrolysis of carboxymethylcellulose with an optimal pH of 6.5, a K_m of 1.2 mg ml^{-1}, and a V_{max} of 280 units. The purified enzyme specifically hydrolyzed the 1, 4-β-glucosyl linkages of carboxymethylcellulose, phospho-swollen cellulose, lichenan, xylan and xyloglucan. The activity of the enzyme was strongly stimulated by cysteine-HCl. The N-terminal sequence of the enzyme was similar to that of an extracellular endo-1, 4-β-glucanase found in suspension sultures of poplar cells and some homology was recognized to avocado fruit-ripening and bean abscission endo-1, 4-β-glucanases.

Plant specific genes in woody plants, H. KURODA: The 4th Division Report of the Japan Wood Research Society, pp. V**21**–V**24** (1995) (in Japanese).

Plant genes, especially from trees, are reviewed. First, genes from trees so far reported were summerized. In second section, organ specific genes in vascular systems or in cell wall were described. Final section descussed how woody plants have been originated.

Transformation of woody plants by particle delivery system, H. KURODA: The 4th Division Report of the Japan Wood Research Society, pp. V**26**–V**28** (1995) (in Japanese).

Particle bomberdment system in woody plants was evaluated with references.

Bio-remediation by woody plants, H. KURODA: The 4th Division Report of the Japan Wood Research Society, pp. V**96**–V**103** (1995) (in Japanese).

This article proposed an idea, "to learn evolutional strategies of plants that have largely been suffered from intense environmental changes which had occured on the earth". This carries many hints if people plan to concern the "bio-remediation by plants". Available genes were also reviewed to regulate deterioraion of wood without toxic chemicals.

Non-chlorine bleaching of kraft pulp II. Ozanation of methyl 4-*O*-ethyl-β-D-glucopyranoside (1) Preparation of authentic carbonyl sugars and their analysis by gas chromatography and mass spectrometry, T. KISHIMOTO, F. NAKATSUBO, K. MURAKAMI and T. UMEZAWA: *J. Wood Chem. Technol.*, **15**, 453–471 (1995).

Methyl 4-*O*-ethyl-β-D-glucopyranoside (1) was prepared as a model compound for cellulose to investigate the reactions of ozone with polysaccharides during ozone bleaching of kraft pulp. The model compound was converted into authentic carbonyl sugars, methyl 3, 6-di-*O*-acetyl-4-*O*-ethyl-β-D-*arabino*-hexopyranosidulose (2), methyl 2, 6-di-*O*-acetyl-4-*O*-ethyl-β-D-*ribo*-hexopyranoside-3-ulose (3), methyl 2, 3-di-*O*-acetyl-4-*O*-ethyl-β-D-*gluco*-hexodialdo-1, 5-pyranoside (4). These carbonyl sugars were converted into *O*-methyl-oximes and analyzed by gas chromatography and mass spectrometry.

Enantiomeric composition of (−)-pinoresinol, (+)-matairesinol and (+)-wikstromol isolated from *Wikstroemia sikokiana*, T. UMEZAWA and M. SHIMADA: *Mokuzai Gakkaishi*, **42**, 180–185 (1996).

Three lignans, (−)-pinoresinol, (+)-matairesinol, and (+)-wikstromol, were isolated from *Wikstroemia sikokiana*. This is the first report of lignan isolation from this plant. Chiral high-performance liquid chromatographic analysis showed that (+)-matairesinol and (+)-wikstromol were optically pure, whereas (−)-pinoresinol was not (74% enantiomer excess). Based on the result, lignan biosynthesis of *W. sikokiana* is discussed in comparison with *Forsythia* plants which are known to produce the opposite enantiomers, (+)-pinoresinol and (−)-matairesinol.

Formation of the lignan (+)-secoisolariciresinol by cell-free extracts of *Arctium lappa*, T. UMEZAWA and M. SHIMADA: *Biosci. Biotech. Biochem.*, **60**, 736–737 (1996).

Cell-free extracts of petioles of *Arctium lappa* catalyzed enantioselective formation of (+)-secoisolariciresinol [about 20% enantiomer excess *(e.e.)*] from achiral coniferyl alcohol in the presence of NADPH and H_2O_2. This is the first report of an enzymatic reaction to afford (+)-secoisolariciresinol enantioselectively.

A new biomimetic degradation of nonphenolic α-carbonyl β-*O*-4 lignin model compounds with Mn(III) in the presence of oxalate and dimethylsulfoxide, T. HATTORI, N. KONDOU and M. SHIMADA: *Mokuzai Gakkaishi*, **41**, 1176–1178 (1995).

The nonphenolic β-*O*-4 lignin model compounds with two electron-pulling groups were broken down with Mn(III) in the presence of oxalate and DMSO, yielding the C_α-C_β bond cleavage and C_β-ether bond cleavage products such as 4-*O*-ethylvanillic acid and vanillin, respectively.

Recent advances in microbial, enzymatic, and biomimetic lignin degradation research, M. SHIMADA: *Proceedings of the 6th International Conference on Biotechnology in the Pulp*

and Paper Industry: Advances in Applied and Fundamental Research, 17–23 (1995).

Recent advances in microbial, enzymatic, and biomimetic lignin degradation research were briefly outlined, focusing on the roles of lignin peroxidase (LiP), manganese peroxidase (MnP), and laccase (Lac) of white-rot fungi. The recent microbial approach indicates that there is a good correlation between MnP activity and fungal pulp bleaching activity. The MnP system has been reported to cleave nonphenolic lignin model compounds under certain conditions, and the Lac system has been shown to depolymerize lignosulfonate in cooperation with veratryl alcohol (VA) and VA oxidase. A novel oxalate-dependent MnP-mimetic system has revealed to have the super enzyme activity in cleavages of both C_α-C_β bond and β-ether bond of the recalcitrant β-*O*-4 lignin model compound with two electron withdrawing carbonyl groups.

On the mechanism of LiP/MnP induction in washed mycelium of *Phanerochaete chrysosporium*, D.B. Ma, Z.J. Lio, B.L. Gong, P.J. Gao, Z.N. Wang and M. Shimada: *Proceedings of the 6th International Conference on Biotechnology in the Pulp and Paper Industry: Advances in Applied and Fundamental Research,* 413–417 (1995).

The effects of different buffers, Tween 80, and the age of fungal cultures on the lignin and Mn peroxidase (LiP/MnP) induction by veratryl alcohol (VA) and Mn^{2+} were investigated in washed mycelia of *Phanerochaete chrysosporium.* Sodium (trans)aconitate buffer was shown to play a role necessary for the induction of LiP/MnP expression by VA/Mn^{2+}. Preliminary experiment suggests that Tween 80 increases LiP/MnP activities by modifying plasma membrane permeability rather than through being metabolized. Only when the mycelia have entered into stationary growth phase under nutritional limitation can LiP/MnP be induced. VA and Mn^{2+} showed cross-induction effects on the LiP/MnP formation in washed mycelia of *P. chrysosporium*, which means that VA promoted MnP synthesis in the presence of Mn^{2+}, and that, on the other hand, Mn^{2+} also promoted LiP synthesis in the presence of VA.

Oxidative breakdown of β-*O*-4 type LCC model compound by lignin peroxidase from *Phanerochaete chrysosporium*, T. Tokimatsu, S.-H. Ahn, T. Umezawa, T. Hattori and M. Shimada: *Proceedings of the 6th International Conference on Biotechnology in the Pulp and Paper Industry: Advances in Applied and Fundamental Research,* 455–457 (1995).

The enzymatic oxidation of the *erythro-* ($1e_2$) and *threo-* ($1t_2$) forms of LCC model substrate (1) with lignin peroxidase (LiP) from *Phanerochaete chrysosporium* yielded 4-*O*-ethylvanillin (P_1) as a major product. Another product, a 1-(4-ethoxy-3-methoxyphenyl)-1-oxo-2, 3-propanediol (P_2) was obtained alternatively only after the longer incubation with the greater amounts of the enzyme. The results indicate that the C_α-C_β bond and the C_α-ether linkage with glucose moiety were cleaved by the enzymatic oxidation.

A novel MnP-mimetic breakdown of recalcitrant nonphenolic lignin model compounds with two electron pulling groups in the presence of Mn(III) and oxalate, T. HATTORI, N. KONDOU, S. MIYATA and M. SHIMADA: *Proceedings of the 6th International Conference on Biotechnology in the Pulp and Paper Industry: Advances in Applied and Fundamental Research,* 459–462 (1995).

Nonphenolic dimeric lignin model conpounds with two electron-pulling groups such as 1-(4-ethoxy-3-methoxyphenyl)-1-oxo-2-(4-formyl-2-methoxyphenoxy)propane-3-ol and 1-(4-ethoxy-3-methoxyphenyl)-1-oxo-2-(4-formyl-2-methoxyphenoxy)ethane were broken down with Mn(III) in the presence of oxalate and dimethyl sulfoxide (DMSO), yielding the Cα-Cβ bond cleavage and Cβ-ether bond cleavage products such as 4-*O*-ethylvanillic acid and vanillin, respectively.

None of the cleavage reactions occurred in the control systems without either Mn(III), oxalate or DMSO. Possible mechanisms for these unprecedent degradation of lignin models are discussed.

Synthesis of four diastereomeric lignin carbohydrate complexes (LCC) model compounds composed of a β-*O*-4 lignin model linked to methyl β-D-glucoside, T. TOKIMATSU, T. UMEZAWA and M. SHIMADA: *Holzforschung,* **50**, 156–160 (1996).

A new method for the synthesis of four diastereomeric lignin carbohydrate complexes (LCC) model compounds composed of a β-*O*-4 lignin model linked to methyl β-D-glucoside is reported. Each of the diastereomers was obtained separately due to asymmetric carbon atoms at the β-*O*-4 substructure and the sugar moiety.

Degradation of non-phenolic β-*O*-4 type lignin carbohydrate complex model compounds by lignin peroxidase from the white-rot fungus *Phanerochaete chrysosporium*, T. TOKIMATSU, S. MIYATA, S.-H. AHN, T. UMEZAWA, T. HATTORI and M. SHIMADA: *Mokuzai Gakkaishi,* **42**, 173–179 (1996).

Non-phenolic β-*O*-4 type lignin carbohydrate complex (LCC) model compounds (1) in *erythro-* and *threo*-forms were oxidized by lignin peroxidase (LiP) from the white-rot fungus *Phanerochaete chrysosporium* Burds. 4-*O*-Ethylvanillin produced as a result of the enzymatic C_α-C_β bond and C_α- ether bond cleavages of 1 was determined by gas chromatography-mass spectrometry. The initial reaction rates of formation of the cleavage product from the diastereomeric isomers of 1 were compared with those of the diastereomeric β-*O*-4 model compounds (2), veratryl alcohol xyloside (3), and veratryl alcohol (4). The reaction rates decreased in the following order: $4>3\approx2>1$. The amounts of the benzaldehyde products produced from LCC model substrate 1 were decreased by addition of oxalate into the LiP system. However, oxalate added was concomitantly decomposed to carbon dioxide. It is noteworthy that, in contrast to the smaller reaction rates of the formation of benzaldehydes from the LCC model substrates (1 and 3), the LCC model substrates were more effective

than the corresponding non-sugar analogs (2 and 4) in decomposing the oxalate. The inhibition of the formation of the cleaved product by oxalate was explained as such that the cation radical intermediates of LCC model substrates formed by the one-electron oxidation oxidized oxalate to CO_2, and was concomitantly reduced back to the substrates level.

Evidence for the role of the glomerulocyte in cellulose synthesis in the tunicate, *Metandrocarpa uedai,* S. KIMURA and T. ITOH: *Protoplasma,* **186**, 24–33 (1995).

The tunicate, *Metandrocarpa uedai,* contains a large quantity of cellulose; however, it is not known how and where the cellulose is synthesized. Based on evidence from electron diffraction and conventional thin-sectioning for electron microscopy, this study shows that the glomerulocyte is involved in the synthesis of cellulose. The bundles of microfibrils in the glomerulocyte as well as the tunic were identified as cellulose I using selected area electron diffraction analysis. The diffraction pattern of cellulose in the glomerulocyte was similar to that from the tunic, suggesting that the crystallization of celluslose already is initiated in the glomerulocyte. The diameter of cellulose microfibrils, both in the glomerulocyte and the tunic was the same, about 16 nm. These results suggest that the glomerulocyte is the most probable site for the synthesis of cellulose in the tunic of *M. uedai.* Using thin-sectioning techniques, a series of observations showed that individual microfibrils are primarily assembled in structures tentatively identified as vacuole-like structures, then they are bundled by a tapering region within the vacuole-like structures. These bundles of microfibrils are deposited in a continuously circular arrangement. The microtubules are oriented parallel to the bundles of microfibrils at the tapering vacuole-like structure, and they may be involved in the tapering of these structures (perhaps controlling the shape). This study also provides the first account for the involvement of a vacuole-like structure in the synthesis of cellulose microfibrils among living organisms.

Identification of wood excavated from the site AM17 in Medical School of Kyoto University, T. ITOH: Annual Report on the Archaeological Research of Kyoto University Site in 1992, Center for Archaeological Operations, 56–57, plate 15–16 (1995).

The tree species of 34 carbonized wood excavated from AM17 site in the Medical School of Kyoto University (13th–14th century) was identified using reflection microscope. The following species was identified : Sciadopitys verticillata (1), Chamaecyparis obtusa (1), Quercus sp. Lepidobalanus, Sect. Cerris (22), Quercus sp. Cyclobalanopsis (7), Fagus crenata (1), Bambusoideae (1).

Identification of wood excavated from the site BA28 in Northern Campus of Kyoto University, T. ITOH: Annual Report on the Archaeological Research of Kyoto University Site in 1992, Center for Archaeological Operations, 114, plate 31 (1995).

The tree species of 6 carbonized wood excavated from BA28 site in Northern Campus of

Kyoto University (early in 10th century) was identified using reflection microscope. The following species was identified: Coniferous species (1), Clethra barbinervis ? (1), Ilex sp (2), Callicarpa japonica ? (1).

Supermolecular structure of cellulose I, J. SUGIYAMA and T. OKANO: *Trends in Macromol. Res.*, **1**, 315–322 (1994).

The strategy of structural analysis of celluloses to date was reviewed with a special reference to the solid state structure.

Crystalline cellulose I_α and I_β studied by molecular dynamics simulation, A.P. HEINER, J. SUGIYAMA and O. TELEMAN: *Carbohydr. Res.*, **273**, 207–223 (1995).

A recent structure determination of native cellulose has shown that it is composed of two different crystal structures, a two-chain monoclinic phase and a single-chain triclinic phase. In this article a molecular dynamics study of the two allomorphs is presented, and a general picture of structure and energetics is provided. Consistent with experimental data, the monoclinic phase is more stable than the triclinic phase by -8.7 kJ mol^{-1} cellobiose^{-1}. In the monoclinic phase a small angle is observed between glucose residues that belong to alternate (200) planes. The glucose residues in every second plane are parallel to the (200) plane, and form more favorable intermolecular hydrogen bonds. In the triclinic phase the glucose residues are not parallel to the (200) plane. The ^{13}C NMR shifts for C-6 are fully accounted for by the distribution of the C-6 dihedral angle. The nonbonded environment is important to the splitting for C-1. The fine structure of IR spectra in the OH-stretching region can be qualitatively correlated with the number of different hydrogen bonds observed. Results indicate that chains in one set of alternating (200)-planes in the monoclinic phase resemble the triclinic phase.

Characterization of tension and normally lignified wood cellulose in *Populus maximowiczi*, M. WADA, T. OKANO, J. SUGIYAMA and F. HORII: *Cellulose*, **2**, 223–233 (1995).

Unlignified tension wood and normally lignified wood celluloses in *Populus maximowiczii* were investigated with particular reference to the composition of two crystalline phases I_α/I_β (triclinic/monoclinic). Four independent techniques, which enable us to detect the two phases, CP/MAS ^{13}C NMR, Fourier transform infrared microscopy, selected-area electron diffraction, and X-ray diffraction were applied. Because of the low crystallinity of wood celluloses, particularly in the case of celluloses in the lignified cell wall, no single method was decisive enough to be able to determine the composition of the two phases as one can with highly crystalline materials. The I_β dominant structure (monoclinic crystal type) was, however, preferred for both tension and normal wood celluloses.

Structural study of α chitin from the grasping spines of the arrow worm (*Sagitta* spp.), Y. SAITO, T. OKANO, H. CHANZY and J. SUGIYAMA: *J. Structur. Biol.*, **114**, 218–228

(1995).

The highly crystalline α chitin occurring in the grasping spines of *Sagitta* was investigated by electron diffraction together with high-resolution electron microscopy. These techniques confirmed the presence of diffraction spots 001 and 0k0 with l or k of odd order. These reflections, which should be absent in the $P2_12_12_1$ space group, were identified as originating from double diffraction effects resulting from the high perfection of the samples as well as their thicknesses. This study confirms therefore the antiparallelism of the chitin chains in a system that can be considered as a model for α chitin.

Induction of tension wood in GA_3-treated branches of the weeping type of Japanese cherry, *Prunus spachiana*, K. BABA, K. ADACHI, T. TAKE, T. YOKOYAMA, T. ITOH and T. NAKAMURA: *Plant Cell Physiol.*, **36**(6), 983–988 (1995).

GA_3 prevented the bending of branches in the weeping type of Japanese cherry, *Prunus spachiana*. Eccentric growth of GA_3-treated branches was observed. In the xylem on the upper side of such branches the presence of gelatin fibers, which stained strongly with fast green, was demonstrated. Moreover, a less dense distribution of vessels and a steeper angle of cellulose microfibrils in the secondary walls of fibers were also observed on this side. Similar features were noted in the xylem of the branches of cherry trees of the upright type, but they were not found in GA_3-untreated control branches of trees of the weeping type. These results suggest that GA_3 induces tension wood on the upper side of branches of *Prunus spachiana* of the weeping type, so that the branches become to grow upwards, resembling branches of the upright type.

Purification and characterization of an aryl-alcohol oxidase from the lignin-degrading basidiomycete *Phanerochaete chrysosporium*, Y. ASADA, A. WATANABE, Y. OHTSU and M. KUWAHARA: *Biosci. Biotech. Biochem.*, **59**, 1339–1341 (1995).

The activity of aryl-alcohol oxidase was detected in the mycelial extracts of a lignin-degrading basidiomycete, *Phanerochaete chrysosporium*. The induction of production of the enzyme by aryl-alcohols was suggested. The enzyme was purified to homogeneity. The molecular weight was estimated to be about 78,000. The prosthetic group was found to be FAD. Several aryl-alcohols can serve as substrates but aliphatic alcohols are inert.

Structures of genomic and complementary DNAs coding for *Pleurotus ostreatus* manganese (II) peroxidase, Y. ASADA, A. WATANABE, T. IRIE, T. NAKAYAMA and M. KUWAHARA: *Biochim. Biophys. Acta*, **1251**, 205–209 (1995).

To study the mechanism of regulation and structure/function relationship of the *Pleurotus ostreatus* manganese (II) peroxidase (MnP), we amplified the full-length genomic and complementary DNAs for the major isozyme of the MnP mainly by the cassette-primer PCR technique and then sequenced them. The cDNA contained an open reading frame of

1083 bp encoding for a polypeptide of 361 amino-acid residues, including the suggested signal peptide of 29 amino-acid residues with a prepro structure. The predicted amino-acid sequence of the protein shared several common characteristics with those of fungal lignin and manganese (II) peroxidases. We could find a suggested metal response element and two heat-shock element-like sequences in the 5′-flanking region of the structural gene. The structural gene contained 15 introns, many of which lie identical to those in lignin peroxidase genes rather than to those in the known MnP genes.

Degradation of tyrosine in bamboo shoots *(Phyllostachys pubescens)* by lactic acid bacteria, K. NAKANISHI and M. KUWAHARA: *Nippon Shokuhin Kagaku Kaishi,* **43**, 251–258 (1996).

Tyrosine degradable activity by lactic acid bacteria was examined using tyrosine as a substrate by stationary culture. The activity was assayed by measuring the decrease in tyrosine in the medium by photodiode array detection in HPLC. Seven strains of lactic acid bacteria which converted tyrosine into tyramine during cultivation were selected from 35 strains of type culture. High activity was observed in *Enterococcus* sp, and *Lactococcus lactis* subsp. *cremoris*, a hich degraded more than half of tyrosine added in a concentration of 1% (w/v) in three days of cultivation. In the reaction system using growing cells, *Enterococcus faecalis* IFO 3971 and *Lactococcus lactis* subsp. *cremoris* which showed the highest activiwy degraded tyrosine and solubilized white particles composed mainly of tyrosine in bamboo shoots cooked by hot water. After the reaction lactic acid and acetic acid content increased considerably whereas sugar content decreased.

Effects of fungal pretreatment and steam explosion pretreatment on enzymatic saccharification of plant bliomass, T. SAWADA, Y. NAKAMURA, F. KOBAYASHI, M. KUWAHARA and T. WATANABE: *Biotech. Bioeng.,* **48**, 719–724 (1995).

The effects of consecutive treatments by a lignin-degrading fungus *Phanerochaete chrysosporium* and by steam explosion for the enzymatic saccharification of plant biomass were studied experimentally, and the optimal operational conditions for obtaining the maximum saccharification were evaluated. Beech wood-meal was treated by the fungus for 98 days and then by high steam temperatures of 170–230°C with steaming times of 0–10 min. The treatment of the wood-meal by fungus prior to steam explosion enhanced the saccharification of wood-meal. The treated wood-meal was separated into holo-cellulose, water soluble material, methanol soluble lignin, and Klason lignin. The saccharification decreased linearly with the increase in the amount of Klason lignin. It was estimated by the equation for the saccharification of exploded wood-meal expressed as a function of steam temperature and steaming time that the maximum saccharification of wood-meal was obtained by consecutive treatments such as fungal treatment for 28 days and then steam explosion at a steam temperature of 215°C and a steaming time of 6.5 min.

Reaction of lignin peroxidase of *Phanerochaete chrysosporium* in organic solvents, S. YOSHIDA, T. WATANABE, Y. HONDA and M. KUWAHARA: *Biosci. Biotech. Biochem.*, **60**, 711–713 (1996).

Lignin peroxidase of *Phanerochaete chrysosporium* had a high activity of 3, 3′-dimethoxybenzidine oxidation in 70% aqueous ethylene glycol medium. UV/VIS and ESR spectroscopic analyses suggested the difference between the oxidation intermediate of 3, 3′-dimethoxybenzidine in water and that in 70% aqueous ethylene glycol medium.

Treatment of kraft pulp waste water by using ozone and microorganisms in combination, T. SAWADA, M. KUWAHARA, Y. NAKAMURA, F. KOBAYASHI H. ORIKASA and M. OHNAGA: *Proc. 6th International Conference on Biotechnology in the Pulp and Paper Industry* Vienna 275–278 (1996).

The chemical degradation of lignin in the kraft pulp waste water and the biological treatment of the products were studied experimentally under various pH values. The kraft pulp waste water treated with ozone under alkaline condition was effective for increasing the formation of organic acids such as acetic acid and oxalic acid. The time courses in the biological treatment of these organic acids indicated a pattern of diauxic growth which was found in a culture with two substrates.

Reaction of lignin peroxidase in organic solvents, S. YOSHIDA, T. WATANABE, Y. HONDA and M. KUWAHARA: *Proc. 6th International Conference on Biotechnology in the Pulp and Paper Industry* Vienna 401–404 (1996).

Lignin peroxidase (LiP) was modified with acetic acid N-hydroxysuccinimide ester and methoxypolyethylene-glycol succinimidyl succinate. Both native and modified LiPs oxidized 3, 3′-dimethoxybenzidine more effectively in several 70% aqueous water-miscible organic solvents including ethylene glycol and methylcellosolve than in water. Furthemore, LiP catalyzed the oxidation of several phenols and aromatic amines including 3, 3′-dimethoxybenzidine, *o*-, and *p*-phenylenediamines and *o*-aminophenol. UV/visible and ESR spectroscopic analyses suggested differences in oxidation intermediates of 3, 3′-dimethoxybenzidine in aqueous solution and in ethylene glycol solution.

Differential activities of a lipase and protease toward straight- and branched-chain acyl donors in transesterification to carbohydrates in an organic medium, T. WATANABE, R. MATSUE, Y. HONDA and M. KUWAHARA: *Carbohydr. Res.*, **275**, 215–220 (1995).

The potential of lipases and proteases as catalysts for the acylation of carbohydrates in organic media is analized. D-glucose was reacted with various straight- and branched-chain acyl donors in pyridine in the presence of some crude commercial lipase and protease preparations. The results obtained are discussed with respect to the interactions between

the acyl donors and the substrate-binding domeins of the enzymes. The steric effects of acceptor molecules in the transesterification of *p*-nitrophenyl glucosides by *Pseudomonas cepacia* lipase are also discussed.

Comparative characterization of dioxane-soluble lignins released by ball milling and by sheep digestion from forage grasses, T. KONDO, T. WATANABE, T. OHSHITA and T. KYUMA: *J. Sci. Food Agric.*, **68**, 383–388 (1995).

Faecal soluble lignin (FSL), extracted from the faeces of sheep that received orchardgrass and timothy, were compared with 90% dioxane-soluble lignins released by ball milling (MHL) and by subsequent enzymatic hydrolysis (EHL) from the same grasses. FSL contained much less carbohydrate and esterified *p*-coumaric and ferulic acids than MHL and EHL. Although no considerable differences were found in the yields of vanillin and syringaldehyde produced by nitrobenzene oxidation, the molar ratio of syringaldehyde to vanillin was higher for FSL than for MHL and EHL. Such differences in chemical properties among the lignin preparations were confirmed by ^{13}C-NMR spectroscopy. FSL had a lower molecular size compared with MHL and EHL. Results indicated that syringyl-rich lignin fragments with less phenolic acid esters, probably depolymerisation products of the grass lignins, were released by digestion in sheep from the forage grasses.

Structure and microbial decolorization of xylanase-resistant chromophoric xylans isolated from unbleached kraft pulp, K. MIKAME, T. WATANABE, Y. HONDA and M. KUWAHARA: *Wood Res.*, **82**, 28–30 (1995).

Xylanase-resistant chromophoric xylans were isolated from unbleached kraft pulp (UKP) and thier structures were analized. To develop an environmentally safe biobleaching system of UKP, microorganisms able to cleave benzyl ether bond were also screened.

Characterization and microbial treatment of xylanase-resistant xylans extractable from unbleached kraft pulp, T. WATANABE, K. MIKAME, Y. HONDA and M. KUWAHARA: *Proc. 6th International Conference on Biotechnology in the Pulp and Paper Industry* Vienna 99–102 (1996).

A water-soluble xylanase-resistant xylan fraction (LF-D) was separated from a hardwood unbleached kraft pulp (UKP) after hydrolysis with a cellulase/ xylanase-membrane bioreactor. LF-D contained over 70% unremovable inorganic atoms including Na, Si, and S, together with a β-1, 4-linked xylan chain. A nucleus exchange reaction and a nitrobenzene oxidation showed that LF-D contained a trace amount of a lignin component abundant in quinoid structures which had been partly demethylated during the course of kraft pulping. The chromophoric xylanase-resistant xylan fraction (LF-D) was partially decolorized by *Trametes versicolor* and bacterial microflora without action of extracellular

lignin peroxidase, Mn-peroxidase, laccase or xylanase.

Molecular cloning of genes encoding manganase peroxidase (MnP) from *Pleurotus ostreatus*, T. TAKAHASHI, Y. HONDA, T. WATANABE and M. KUWAHARA: *Wood Res.*, **82**, 25–27 (1995).

Genomic and cDNA fragments encoding manganese peroxidase (MnP) from white rot fungus, *Pleurotus ostreatus* were obtained by PCR-mediated cloning method and their sequence properties were characterized. Comarison of the putative amino-acid sequence with MnP from *Phaerochaete chrysosporium* was also shown.

Functional distinction among structural subsections in the specific priming signal for DNA replication of the broad host-range plasmid RSF1010, D.-M. MIAO, H. SAKAI, K. TANAKA, Y. HONDA, T. KOMANO and M. BAGDASARIAN: *Biosci. Biotech. Biochem.*, **59**, 920–921 (1995).

To analyze the functional contribution to the *ssiA* function of subsections of the *ssiA*-determinant sequence based on their dimensions, we constructed *ssiA* mutants carrying insertions and deletions. Results of the examination of the examination of the *ssiA* mutants told us that, in addition to the base sequence, the dimensions were crucial factors for the functional contribution of the subsections of *ssiA*.

The interaction of RepC initiator with iterons in the replication of the broad host-range plasmid RSF1010, D.-M. MIAO, H. SAKAI, S. OKAMOTO, M. OKUDA, K. TANAKA, Y. HONDA, T. KOMANO and M. BAGDASARIAN: *Nucl. Acids Res.*, **23**, 3295–3300 (1995).

The replication origin of the broad host-range plasmid RSF1010 contains 3.5 copies of a 20mer iteron sequence that bind specifically to the plasmid-encoded initiator, RepC. Here we demonstrated that even a single iteron was bent upon binding of RepC. Moreover, the bending angle seems to become larger along with the increment of the number of iterons. In a mutational analysis of the iteron sequence, we isolated seven kinds of base-substitution mutants of iterons, and estimated the replication activity of these mutants *in vivo*. We found that each of the subsections in the 20 mer iteron sequence made a distinct contribution to the initiation of RSF1010 DNA replication. With the binding assay of RepC and mutated iterons *in vivo*, we found that the formation of a productive RepC-iteron complex was required for the initiation of plasmid DNA replication.

Dimensional stabilization of compressed wood, M. INOUE: *Rheology of wood and wood-based materials, Recent investigation,* ed. Rheology Research Group of Wood Res. Soc., p. 115–118 (1995) (in Japanese).

Recent investigation on compressed wood are reviewed. As the treatment for dimensional stabilization of compressed wood, phenol or melamine resin treatment, heating,

steaming and hygrothermal treatment are explained.

Recent technology for production of compressed wood, M. INOUE : *APAST,* **17**, 5–9 (1995) (in Japanese).

The behavior of the large transverse compressive deformation of wood, physical properties of compressed wood, recovery of the deformation by the influence of moisture and heat, and several methods and mechanisms to fix the compressive deformation are reviewed.

Making and using of compressed wood, M. INOUE : *Wood Head,* Vol. **1**, No. **3**, 2–7 (1995) (in Japanese).

Recent investigations on compressed wood are reviewed. Some examples of utilization of compressed wood are also introduced.

How to manufacture and utilize compressed wood, M. INOUE, K. NAKATA, S. KAWAI and M. NORIMOTO : *Proc. of '96 MRS-J Symposium D, The Latest Progress of New Plant Materials,* p. 109–112, (1996).

Mechanical properties of wood such as stiffness, strength, hardness and abrasion resistance can be improved by compression perpendicular to the grain, which also gives more uniform properties. However, the compressed wood is known to recover almost to its initial state under the influence of both moisture and heat. The deformation in wood is thought to be fixed by the following three kinds of methods ; to make the wood inaccessible to water, to form crosslinks between the wood components, and to release the elastic energy stored by deformation. Treatment with a low molecular weight phenol or melamine-formaldehyde resin, heating, or steaming are all effective methods to permanently fix the compression in wood.

Techniques required for producing dimensionally stable wood-based panels, mechanisms and methods to reduce thickness swelling, N. SEKINO and M. INOUE : *Mokuzai Kogyo (Wood Industry),* Vol. **51**, No. **5**, 194–197 (1996) (in Japanese).

Mechanisms and methods of thickness swelling of wood-based materials by the influence of moisture and heat are reviewed. The technical methods for its dimensional stabilization are also introduced.

Basic properties of particleboards made of steam-pretreated wood flakes, N. SEKINO AND M. INOUE : *J. Fac. Agri. Iwate Univ.,* Vol. **22**, No. **4**, 169–176 (1996) (in Japanese with English summary).

Particleboards manufactured with urea-formaldehyde resin and wood flakes steam-pretreated at temperatures of 120–140°C, for one hour, showed the following characteristics, when compared with a control board : 1) decrease in counterpressure of mattress during hot-pressing, 2) no distinct change in moduli of rupture and elasticity in bending, but a tendency

for a ratio of proportional limit stress to modulus of rupture to increase with pretreatment temperature, 3) decrease in internal bond strength up to twenty percent, 4) no improvement in thickness swelling. To clarify the reason for the dimensional unstability, changes in thickness recovery stress and adhesive bond strength caused by steam-pretreatment were investigated for 2mm thick veneers as a model flake. It was found that the steam pretreatment at 110–130°C for 30–120 minutes, caused decrease in thickness recovery stress with treatment temperature and time, however, it also decreased adhesive bond strength almost to the same extent. As part of a systematic study for an understanding of dimentional stabilization by steam pretreatment, the effect of steam temperature, over the range of 120–220°C, on the thickness recovery of compressed wood was investigated. It was found that the thickness recovery decreases remarkably with temperature, when steam-treated above 170–180°C. This suggests a possibility that dimentionally stable particleboards will be obtained by a high temperature and short time steam pretreatment.

Effect of ventilation on humidity conditions by wood, T. OHOGAMA, T. UENO and M. NORIMOTO: *Wood Research and Technical Notes,* No. **31**, 56–63 (1995) (in Japanese).

The relative humidity and temperature in the steel box lined with wood which had two ventilating pipes (exhaust and inhalant pipes) on its upside were measured during ventilation at constant intervals when its ambient temperature was periodically changed in the range from 15°C to 25°C for 24 hours. The changes of relative humidity with the changes of temperature outside of the box were estimated by assuming a constant absolute humidity. The logarithm of relative humidity in the box was approximately represented by a linear equation of temperature. The extent of humidity conditions by wood in the box was evaluated by the slope B of the equation. The relationship between the B-value and the ratio of area lined with wood (A) to volume (V) of the box (A/V) or the number of air changes was investigated. With increasing the number of air changes the B-value decreased and the effect of A/V on the B-value reduced. It was estimated that the amount of moisture absorption and desorption and desorption of wood increased with decreasing A/V and with increasing the number of air changes.

The large compressive deformation of wood in the transverse direction (II), Stress-strain diagram with increasing loading cycles, L. YIXING, M. NORIMOTO and T. MOROOKA: *Wood Research and Technical Notes,* No. **31**, 44–55 (1995) (in Japanese).

The compressive tests with increasing loading cycles in the radial direction for sugi *(Cryptomeria japonica)* and inuside *(Carpinus tschonoskii)* woods were carried out in three conditions: air-dry at 20°C, wet at 20°C, wet at 100°C. The deformation in the tangential direction was either free or restricted.

In air-dry condition at 20°C, a large residual strain remainded after unloading above the yield point. The difference in the stress-strain diagrams with and without lateral

restriction for sugi wood was slight, showing that most of the radial compressive strain was absorbed by internal buckling of the cell walls. However, the diagram without lateral restriction for inuside wood showed a lower yield stress and higher strain levels. This was related with the Poisson's ratio at large deformation.

In wet conditions at 20°C and 100°C, an almost complete recovery of strain was observed whatever maximum stress level had been reached. However, subsequent loadings never followed the previous path and a new plateau with a much lower yield stress was observed.

These results suggested that some ultrastructural damages in the cell walls by loading history occurred, although there were no indications of the damages through SEM observation.

The investigation on two by four construction houses in the district devastated by the Hanshin earthquake, M. NORIMOTO, Y. IMAMURA, S. KAWAI, S. TAKINO, N. ANDO, J. HASHIMOTO, T. NAKAO and U. TSUDA: *Wood Research and Technical Notes,* No. **31**, 64–80 (1995) (in Japanese).

The damages of fourteen 2 by 4 construction houses in the district devastated by the Hanshin earthquake were investigated.

Moisture adsorption thermodynamics of chemically modified wood, R. YASUDA, K. MINATO and M. NORIMOTO: *Holzforschung,* **49**(6), 548–554 (1995).

The isotherms for untreated and chemically modified wood specimens were analyzed using the Hailwood-Horrobin equation. The enthalpy (ΔH), entropy (ΔS) and free energy (ΔG) changes during moisture adsorption were estimated. The ΔH, ΔS and ΔG values of untreated wood were compared with those found in literature as well as those of specimens treated with formaldehyde (formalization), acetic anhydride, glyoxal, glutaraldehyde and dimethylol dihydroxy ethyleneurea (DMDHEU). The ΔH of the untreated specimen was almost constant up to ca. 3% of moisture content differing from the results reported by others. However, the bonding energy of hydrated water molecules, which represented a large portion of the adsorbed water in the low moisture content range, should not depend on the moisture content, so that the result was undoubtedly reasonable. The decrease of the absolute ΔH for formalization and acetylation indicates the remarkable loss of the hydrated water as a result of those reactions. A peak of the absolute ΔS found at ca. 3% of moisture content except for acetylation may reflect the rearrangement of adsorption sites associated with taking up a little amount of water. In the acetylation, such rearrangement could not occur because of the introduction of bulky hydrophobic groups. Remarkable increases of both absolute ΔH and ΔS observed in glyoxal treated specimens will be due to the ester groups introduced. The ΔG values of all treated specimens became less negative than that of untreated. This indicates the formation of some bond which restricts the swelling of

wood structure.

Quantitative expression on the large transverse compressive deformation relationships between stress and strain of wood, L. YIXING, M. NORIMOTO and T. MOROOKA: *Scientia Silvae Sinicae,* **31**(5), 436–442 (1995) (in Chainese).

In this paper, seventeen species of hardwood were chosen in the variation range of 100–130 kg/m^3 wood density. The large Transverse compression deformation test and the collection of quantitative data were conducted under six kinds typical conditions of wood compression. (The conditions are the combination of three kinds of conditions which are airdried·20°C, saturated water·20°C and saturated weter·100°C with the restricting conditions). On the basis of data analysis, the formulas which express quantitatively the relationship between stress and strain and stain were founded as following:

when $\varepsilon \leqslant \varepsilon_y \quad \sigma = E_\varepsilon$

when $\varepsilon > \varepsilon_y \quad \sigma/\sigma_y = 1 + C\left\{\dfrac{\varepsilon_d}{[\varepsilon_d - (\varepsilon - \sigma_y/E)]} - 1\right\}$

$\varepsilon_d = 1 - K(\rho/\rho_s)$

In the formulas above, E is elastic modulus in transverse direction; σ_y is yield stress; ε_y is yield strain; ε_d is a measure of the strain when all of the pore space in wood is squeezed out. C is the armature of increasing speed of stress when strain above the yield point; ρ and ρ_s refer to density of wood and material density of the cell wall respectively. K is a constant that depends on the factors such as the restricting conditions of compressive test, $0 \leqslant K \leqslant 1$.

The formulas above is adaptable to the tree species and the compressive conditions under the test conditions in this paper. Moreover, the results of calculation were very concordant with the data of experiment.

Quality evaluation of clarinet reed made of different materials, E. OBATAYA, M. NORIMOTO and M. MAGAMATSU: *J. Acoust. Soc. Jpn. (J),* **52**(1), 24–29 (1996) (in Japanese).

Clarinet vibrating reeds were made of 7 kinds of materials and their qualities were evaluated by clarinet players. The evaluated timbre values whose variation was small among the players were compared with some physical properties of materials of the reeds. The evaluated timbre values T_m were correlated with the values of sound velocity in the length direction of the reeds (V_L) and was reversely correlated with the values of dynamic Young's modulus in the width direction of reeds (E_W). Consequently, there was an excellent linear correlation between T_m and log ($V_L{}^7/E_W$). The T_m values of the plastic reeds were very low and the reason was considered to be in their isotropic nature. On the other hand, the T_m values of reeds made of akamatsu and kiri woods were larger than those made of cane (*Arundo donax* L.). This result suggested that some kinds of wood could be used for the reed materials.

The water sorption isotherms of cane (*Arundo donax* L.) used for reeds of woodwind instruments, E. OBATAYA and M. NORIMOTO: *Mokuzai Gakkaishi,* **41**(12), 1079–1085 (1995) (in Japanese).

The water sorption isotherms of cane (*Arundo donax* L.), before and after water extraction, and isolated extractives were obtained. The equilibrium moisture content of cane before extraction was less at relative humidities below 40% and larger at those above 50% than that after extraction. The extractives scarcely adsorbed water at small relative humidities, but much at large humidities. The fiber saturation point of cane before extraction was estimated to be above 35%, whereas that after extraction was 21%.

By applying the Hailwood-Horrobin's equation to the isotherms of cane, the hydrated and dissolved waters were separated. After extraction, the amount of the hydrated water increased, and that of the dissolved water decreased. This result showed that the extractives adsorbed most of water in the from of dissolved water.

The isotherms of the extractives in cane was compared with those of the isolated one. Both the equilibrium moisture contents were almost the same at small relative humidities, but those of the extractives in cane was less at above 50%, especially above 80%. This fact showed that the water adsorption of the extractives existing in the cell walls was restrained.

Mechanical and dielectric relaxations of wood in a low temperature range I, Relazations due to methylol groups and adsorbed water, E. OBATAYA, M. YOKOYAMA and M. NORIMOTO: *Mokuzai Gakkaishi,* **42**(3), 243–249 (1996) (in Japanese).

The dynamic viscoelastic and dielectric properties of spruce (*Picea sitchensis* Carr.) wood along the grain were measured in a temperature range from −150°C to 0°C. A mechanical relaxation and a dielectric relaxation were observed in the absolutely dried condition. The relationships between logarithms of the frequencies at loss peaks and reciprocals of absolute temperature were represented by a linear equation. The apparent activation energies for these relaxations which were considered to result from the motions of methylol groups in the amorphous region of the cell wall were 9.8 kcal/mol. Other mechanical and dielectric relaxations appeared in the presence of a small amount of water. With increasing moisture content, the loss peaks for these relaxations increased and their temperature locations shifted to lower temperatures. The apparent activation energies for these mechanical and dielectric relaxations were 16 kcal/mol and 17 kcal/mol, respectively. These relaxations were considered to result from the motions of adsorbed water molecules. With increasing moisture content within 1%, the dynamic elastic modulus increased, and the loss peak due to the motions of methylol groups decreased slightly. These results show that the adsorbed water molecules increase the cohesive forces between the constituent molecules of the cell wall and slightly influence the motions of methylol groups.

Thermal and humidity environments of the large wood building, T. MOROOKA,

M. NORIMOTO, O. MASANI, T. MIYAMOTO, T. YAMADA and N. ISODA : *House Clima Research Note,* No. **21**, 9–18 (1995) (in Japanese).

Temperature and humidity variations in a large scale wood building are measured in connection with those for steel building. It was clarified that both the temperature and humidity changes in wooden building measured were markedly reduced as compared with those in steel building. Unexpectedly large reduction observed in the humidity change further indicated that not only the interior wall material but also the wood structure itself affected the humidity change.

House Clima of the large wood building, T. MOROOKA : *Wood Head,* No. **1**, 16–21 (1995) (in Japanese).

Temperature and humidity variations in a large scale wood building were measured, and values obtained were compared with those obtained from calculation based on weighting function method.

Dimensional stabilization of wood by glyoxal resin treatments. A few considerations concerning mechanism of dimensional stabilization, T. ITOH and S. ISHIHARA : *J. Soc. Mat. Sci., Japan,* **45**(4), 390–396 (1996) (in Japanese with English summary).

For the purpose of enhancing dimensional stabilization of wood, Hinoki (*Chamaecyparis obtusa* Endl.) sapwood specimens were treated with the mixtures of cyclic methylolurea-formaldehyde compounds, called "glyoxal resins", and dipropylene glycol (DPG). In this paper, the dimensional stability of the specimens was evaluated, and the mechanism of the dimensional stabilization was discussed. The information obtained was as follows;

(1) Both of the bulking coefficient *(B)* and antiswelling efficiency *(ASE)* of the specimens increased with increasing mixing ratio of DPG in mixture. Their maximal *ASE* endowed by the treatment was more than 70%.

(2) For the specimens treated with the mixtures having constant concentrations, an approximately linear relationship existed between *B* and ASE, with a high correlation coefficient.

(3) For the specimens treathd with the mixtures having a constant ratio of glyoxal resin and DPG, the relationship between weight increase *(W.I.)* and *ASE* was similar to the relationship between *W.I.* and moisture excluding efficiency *(MEE)*. Consequently, it is suggested that the improvement of dimensional stability is also dependent on the decrease of hygroscopicity.

(4) The specimens treated with the dilute mixtures revealed the dimensional stability that was considered to be caused by cross-linking.

Outdoor exposure tests of wood treated with glyoxal resin I. Influence of

reaction temperature on changes of dimensional stabilities, T. ITOH and S. ISHIHARA: *Mokuzai Gakkaishi,* **42**, 397–405 (1996) (in Japanese with English summary).

To evalute weathering properties of wood treated with glyoxal resins, outdoor exposure tests and artificial accelerated tests, such as boiling or wetting and oven-drying cyclic tests, were made. Wood specimens were impregnated with a mixture of glyoxal resin and dipropylene glycol in the ratio of 50 : 50 (weight), followed by heated at 80–150°C, to accelerate the condensation. The information obtained was as follows:

(1) In the outdoor exposure tests, pronouced weight losses *(W.L.)*, especially, in the specimens that were treated at low temperatures, appeared in the early stage of exposure. With increases of *W.L.*, bulking coefficients *(B)* and antiswelling efficiency *(ASE)* decreased, and moisture excluding efficiency *(MEE)* increased. The changes of their values diminished gradually with time.

(2) The occurrence of checks on the wood surface with exposure time, can be prevented by the addition of dimensional stability to wood.

(3) The behaviors of deterioration in resin treated wood in the early stage of the boiling test were similar to those observed in the outdoor exposure. Judging from this result, it is considered that the outdoor exposure and boiling test are closely related to each other.

(4) Generally, the deteriorations of dimensional stabilities in the specimens whose reaction temperatures were low were significant in the early stage of the wetting and oven-drying cyclic test that was used. On the other hand, the deteriorations of the specimens where condensation had proceeded adequately were very little through ten cycles of wetting and oven-drying.

Creep behavior under fire and fire endurance of Japanese cedar, T. KAJIMOTO, T. HATA, S. ISHIHARA and H. GETTO : Abstracts of invited papers, IUFRO XX world congress, Tampere, 361 (1995).

It is getting increasingly important to utilize plantation trees for the earth environment. There are lot of sugi (Japanese cedar) resource in Japan. The orientation of each cell of sugi is excellent, however, there are some problems with the properties, color, and dryness. So they are unsuitable for industrial material use.

In this paper, the authors treated the samples with fire retardants to add fire resistivity and improve the properties of sugi.

The samples were dried after painted with 100–200 g/m^2 reaction products of phosphoric trimethylol melamine. The samples were inserted into hot press with the temperature of 160°C.

It was suggested that the penetration of the chemicals to the surface layers was promoted with hot pressing. It took longer time for the samples with the pressing treatment to be destroyed under fire, compared to those of control. It was due to the fact

that the surfaces were densified and the chemicals transported effectively.

Fire endurance of surface densified wood of *Albizzia falcata* treated with fire retardant, SUBYAKTA, T. HATA, T. KAJIMOTO and S. ISHIHARA: *Wood Research,* **82**, 1–7 (1995).

Bending strength and creep behavior under fire of solid wood, laminated veneer lumber (LVL) and glued-laminated timber of albizzia (*Albizzia falcata* Backer) coated with fire retardant and hot pressed (surface densified) at several temperatures were evaluated. Chemical used was trimethylol melamine mixed with phosphoric acid coated at the amount of 100 g/m^2. Results showed that the fire endurance (time to creep rupture) of surface densified albizzia treated with the chemicals was improved, compared to that of untreated ones. Temperature of hot pressing of 160°C resulted in the longest time to creep rupture. Bending strength of woods was not affected when pressed at the temperature below 200°C.

Mechanism evaluation and development of suppression of wood combustion by boric compounds (1). Oxygen index of filter paper and Douglas fir veneer treated with boric acid and mixture of boric acid-alkali metal hydroxide, WEN-YU SU, T. HATA, Y. IMAMURA and S. ISHIHARA: *Mokuzai Hozon (Wood Preservation, Japan),* **21**(6), 299–305 (1995) (in Japanese with English summary).

For evaluation of the fire performance of cellulosic materials treated with boron compounds mixed with alkali metal chemicals, filter paper and Douglas fir veneers were impregnated with them at different chemical weight gains and tested by oxygen index method. Filter paper and veneers were treated by dipping in the aqueous solutions of boron (boric acid) and alkali metal chemicals (lithium hydroxide, sodium hydroxide and potassium hydroxido) mixed at the molar ratios of 1 : 0, 1 : 0.5, 1 : 1, and 1 : 2.

The results attained were as follows;

1) The oxygen index of filter paper and veneers could be raised up at higher rate by impregnation with the mixed chemicals of boric acid and alkaline metal hydroxide than each separate chemical, showing additive effects obtained by the combined use of them on suppression of flammability of cellulosic materials.

2) The molar ratios of boron and alkaline metals which showed the best flame-suppression ability were 1 : 0.5 for lithium and sodium, and 1 : 2 for potassium, respectively, at 30% of chemical weight gain.

3) The remarkable additive effects obtained by the combination of boron and alkali metals were observed for lithium, and then sodium and potassium in the order. The alkali metal chemicals with the lower atomic number were assumed to be more effective on the flammability suppression.

4) The treated veneers performed higher values of oxygen index than filter paper at the same weight gains due to chemical treatment, though no significant difference was

recognized for untreated ones.

5) The solubility of boron in water could be raised up by mixing with alkali metals, and the weight gains of the samples due to dipping in the mixed solutions were remarkably increased.

Impregnation of liquid into wood—Structure of pits and improvement technology of liquid penetration—, Y. IMAMURA: *Wood Research and Technical Notes,* No. **31**, 11–30 (1995) (in Japanese).

The treatment technology of wood is highly affected by the impregnation of liquid into it, and the permeability of wood is mainly dependent on its channel structure, the pits. The fine structure of the pits was reviewed, and the new trials for the improvement of liquid impregnation into wood were introduced including biological, chemical and physical pretreatments as well as incision techniques.

Liquid penetration of precompressed wood III. Effect of moisture contents of specimens and ambient temperatures while compression on liquid uptakes of softwoods and hardwoods, I. IIDA, A. IKEUCHI and Y. IMAMURA: *Mokuzai Gakkaishi;* **41**, 811–819 (1995) (in Japanese with English summary).

The effects of the precompression treatments on the improvement of liquid penetration into wood was investigated on the heartwoods of seven species of softwoods and hardwoods. Precompression up to 50% deformations under different conditions of the moisture contents of specimens (dry or wet) and ambient temperatures (room-temperature, 30°C or 80°C) effectively increased the liquid uptakes which differed within wood species even when the same levels of compressive deformation were applied. The maximum amount of liquid uptake was obtained when precompressed under wet conditions at 30°C for Douglas-fir (Beimatsu, *Pseudotsuga taxifolia* Britt) and at 80°C for Japanese cedar (Sugi, *Cryptomeria japonica* D. Don.), but no significant difference was observed among the treatment conditions for Japanese cypress (Hinoki, *Chamacyparis obtusa* Endl.) and Japanese larix (Karamatsu, *Larix leptolepis* Gord.). The liquid uptake increased in proportion to the rate of deformation recovery increases while immersion in a dye-solution, which varied with the precompression conditions of specimens and ambient temperatures. SEM observations visualized the opening of the enclosed bordered pits of softwoods and the fractures of the tyloses in the vessels of hardwoods due to the precompression treatments. As a result the liquid penetration was improved remarkably for refractory woods.

Liquid Penetration of Precompressed Wood IV. Mechanical properties of set-fixed wood before and after recovery, I. IIDA and Y. IMAMURA: *Mokuzai Gakkaishi,* **41**, 1165–1172 (1995) (in Japanese with English summary).

The mechanical properties of woods precompressed perpendicular to the grain and the

compressive deformation recovery were evaluated. The strength reductions were fairly small along the fiber axis for the specimens compressed even at the large rate of as much as 60% under water-saturated conditions and ambient temperatures of 20 and 80°C. However, this was not so for specimens compressed under air-dry conditions. The small losses of strength properties suggested that the occurrence of micro-cracks in the cell wall structure was limited as the deformation was applied to the cells horizontally, and it caused less effect on the cellulose microfibrils oriented almost parallel to the fiber axis. When the residual deformations remained in the specimens after precompression and set-recovery, increases of strength properties in the tangential direction and decreases of strength properties in the radial direction were assumed to be caused by the deformation of cell shapes which were flatten when viewing the cross-sections. The small reductions of strength properties after precompression and nearly complete recovery from the deformation promises this treatment should be to develop into an effective and practical method for the improvement of liquid penetration into wood.

Decay and Termite Damages to Houses Disclosed by the Hanshin Earthquake, Y. IMAMURA: *Japan J. Environ. Entomol. Zool.*, **7**, 158–162 (1995) (in Japanese with English summary).

The Hanshin Earthquake at January 1994 destroyed more than hundred thousands wooden-houses at the moment. Decay and termite attacks of wood components were pointed out to be one of the causes of housing damages as well as constructional factors such as improper aeismatic structure, insufficiency of wall-ratio and weakness of joint structure. Severe damages of wood components by decay fungi and termites were frequently disclosed in the walls overlayed by cement-mortar.

The Latest Progress of New Plant Materials, Y. IMAMURA: *Proceedings of '96 MRS-J Symposium D "The Latest Progress of New Plant Materials"*, pp. 337–340, 1996 (in Japanese with English summary).

Wood is the biggest phytomass on the earth and characterized with lignocellulosic components and cellular composites. The material characteristics of wood such as high specific strength, heat insulation and regulation of humidity are depending on the cellular structure consisting of cell-walls, lamella and microfibrils. Looking from the ecological points, wood is excellent in renewability, low-energy consumption in processing, recyclic uses and easiness of disposal. However, to suppress the demerits originating from bio-resources, new-technologies have been developed. Reconstituted wood materials is called as engineering wood reducing the quality demand of raw materials and providing the reliable design of strength. Wood has been chemically-modified or processed to up-grade the long term performance with biological resistance and dimensional stability. Much attention has been paid to more environmental-compatible treatments by using wood

extractives or heat processing. Wood charcoal is also attracting concerns not only for conventional uses but also for new-advanced materials.

Biological properties of chemically modified wood, M. TAKAHASHI: "Chemical Modification of Lignocellulosic Materials", ed. D. N.-S. Hon, 331–361, Marcel Dekker, Inc., New York, Basel and Hong Kong, 370 pp. (1996).

The important topics that should be included on chemical modification of lignocellulosic materials were enumerated in this book. In Chapter 14 described by the author, biological resistance of chemically modified wood and its potential application were discussed, based mostly on his recent works to develope high-performance wood products.

Acetylation and phenolic resin impregnation are found to be applicable to reconstituted products in yielding good biological resistance. Treatments with crosslinking agents and WIC (wood-inorganic material composite) can be applied to these end-products but further studies are required to improve production technology. Current high dependence on preservatives for wood protection can be reduced by proper use of chemically modified wood products.

Field tests of preservative-treated radiata pine in Japan, M. HEDLEY, K. TSUNODA and K. Suzuki: *The Int. Res. Group on Wood Preserv.*, Document No. IRG/WP 95–30083, pp. 3 (1995).

Test stakes of radiata pine treated with various alkyl ammonium compound (AAC) formulations and with copper-chrome-arsenate (CCA) as reference preservative were installed in 3 test sites in Japan in 1981-82. When inspected in 1995, CCA-treated stakes showed less decay at all three sites than stakes treated with other formulations. Ammoniacal copper quaternary (ACQ) treatment was only slightly less effective than CCA at two sites (Tsukuba and Fukiage-Hama), but more markedly less effective at the high decay hazard Uji site. Unamended AAC treatment was least effective, but there was little difference in performance between didecyl dimethyl ammonium chloride (DDAC) and benzalkonium chloride (BAC) formulations.

International collaborative laboratory comparison of two wood preservatives against subterranean termites: Third update and first report, J.R.J. FRENCH, B. AHMAD, N. CHEW, S. CRAGG, J.W. CREFFIELD, J.K. GRACE, B. KARD, M. LENZ, A. SAUNDERS, M.-M. SERMENT, K. TSUNODA and C. VONGKALUANG: *The Int. Res. Group on Wood Preserv.*, Document No. IRG/WP 96–10174, pp. 8 (1996).

At the 24th annual meeting of IRG in Orlando, USA, in May 1993 an international subterranean termite laboratory bioassay to compare the various preferred termite protocols used by IRG termitologists was initiated. The first author was nominated to co-ordinate this comparative laboratory evaluation of two wood preservatives, copper-chrome-arsenic

(CCA) and copper naphthenate (Cu-Na) against the subterranean termites used as test termites in Australia, France, Japan, Thailand, United Kingdom and the United States of America. Solutions of these two wood preservatives were prepared and impregnated into *Pinus radiata* wood blocks to obtain loading of 0.0, 0.5, 1.0, 2.0 and 4.0 Kg/m^3 respectively. All preservative treatments were carried out at the Division of Forestry and Forest Products in Melbourne. The treated specimens were dispatched to the participationg researchers who subjected these specimens to attack by their test termite species, and have now returned the specimens to Melbourne. This paper reports the amount of wood consumed and the mean mass loss (%) on both treated and untreated wood blocks by the termites in the various laboratory bioassays.

Gaseous treatment of timber with allyl isothiocyanate Fungicidal and insecticidal effects, K. TSUNODA and T. YOSHIMURA: *The Int. Res. Group on Wood Preserv.,* Document No. IRG/WP 96-30108, pp. 5 (1996).

Gaseous treatment with allyl isothiocyanate (AIT) was tested for its effects on the growth of microorganisms on the wood substrate and the mortality of subterranean termites and powder-post beetles. Toxic limits of AIT were determined as concentrations in the air when an AIT-treated filter paper was placed in a sealed container with fungus-inoculated wood specimens. Those were <3.8 ppm for *Aureobasidium pullulans,* 7.5–15 ppm for *Aspergillus niger,* 30–59 ppm for *Gliocladium virens,* 59–118 ppm for *Penicillium funiculosum* and >118 ppm for *Rhizopus stolonifer.*

LD_{50} values were determined for insects. Twenty workers of *Coptotermes formosanus* or 10 adults of *Lyctus brunneus* were placed in an air-circulated glass bottle, and the mortality of the test insects was recorded after 24 hours. LD_{50}/24h were 10–13 ppm and approximately 80 ppm in the air for *C. formosanus* and *L. brunneus,* respectively.

Resistance of wood-inorganic material composites against decay fungi and subterranean termites, K. TSUNODA, T. YOSHIMURA, M. TAKAHASHI, S. HIRAO and H. USUI: *The Int. Res. Group on Wood Preserv.,* Document No. IRG/WP 96-40062, pp. 6 (1996).

Double diffusion process was applied to the treatment of small sound sapwood specimens [20(T)×20(R)×10(L) mm] of *Cryptomeria japonica* D. Don. The specimens were consecutively dipped in the two kinds of aqueous solutions to form water-insoluble deposits within the wood after an expected reaction between the solutes. Following the comparison of deposits formed and treating conditions (temperature and solution concentrations), $BaHPO_4$ as a water-insoluble precipitation performed best against decay fungi (*Coriolus versicolor* and *Tyromyces palustris*) and subterranean termites (*Coptotermes formosanus* Shiraki) in the standardized laboratory tests. Addition of boric acid enhanced the performance of the wood-inorganic material composites.

Relatively low weight percent gain by deposits ($<3\%$) was proved effective in

controlling biological deterioration of the treated samples when boric acid was added to the treating solutions.

Methane emission by termites, *Coptotermes formosanus* Shiraki, K. TSUNODA, W. OHMURA, M. TOKORO and T. YOSHIMURA : *The Int. Res. Group on Wood Preserv.*, Document No. IRG/WP/95-10099, pp. 6 (1995).

Association of methanogenic bacteria only with the smallest-sized symbiotic protozoa *Spirotrichonympha leidyl* Koidzumi was evidenced by epifluorescence microscopic observations.

Workers, which were collected from a laboratory colony and placed in a test container with water supply emitted methane at a relatively constant rate with a peak of 0.76 nmol/termite/within the first 72 hrs after the initiation of measurement. Soldiers, as expected, produced less methane with a maximum rate of 0.019 nmol/termite/hr.

Although methane formation is considered important to termites in order to keep physiological balance, that undesirably contributes to global warming.

A study of decay and termite attacks in damaged wooden houses by Hanshin Earthquake, T. YOSHIMURA : *Mokuzai Hozon (Wood Preservation)*, **21**(4), 28–30 (1995) (in Japanese).

The results of survey of decay and termite attacks on damaged wooden houses by Hanshin Earthquake were outlined.

Termiticidal performance of hinokitiol and its derivatives in laboratory test, T. YOSHIMURA, M. TAKAHASHI, Y. YOSHIDA, T. INUKAI, T. CHIBA and N. KATO : *Jpn. J. Environ. Entomol. Zool.*, **7**(2), 72–78 (1995).

The termiticidal performance of hinokitiol (β-thujaplisin), its two glucosides, and an acyl-derivative was investigated using a laboratory bioassay with reference to their effects on the protozoan fauna in the hindgut. Hinokitiol was the most effective against workers of *Coptotermes formosanus* Shiraki among these chemicals, followed by hinokitiol *n*-octanoate, in a filter paper test. The two glucosides showed delayed activity. Even hinokitiol needed more than a hundred times the amount of chemical to meet the same level of effectiveness compared to authentic temiticides, therefore, these chemicals did not seem to be alternatives for conventional preventive and/or remedial termite controlling methods. All test chemicals certainly affected the protozoan fauna in the hindgut. From the change of the protozoan fauna of workers fed on treated filter papers, it appeared that derivatives needed to be converted into hinokitiol for expressing their anti-microbial activity, and that glucosides were more easily converted into hinokitiol than hinokitiol *n*-octanoate. Novel formulations such as baiting techniques should be concerned when practical application of hinokitiol and its derivatives is considered.

Contribution of the protozoan fauna to nutritional physiology of the lower

termite, *Coptotermes formosanus* Shiraki (Isoptera : Rhinotermitidae), T. YOHIMURA : *Wood Res.*, **82**, 68–129 (1995).

This review article is the abstract of the Ph.D. thesis by the author and deals with the role of the protozoan fauna to nutritional physiology of the most economically important pest for wooden constructions in Japan, *Coptotermes formosanus* Shiraki. From the results obtained in a series of research works, the wood decomposition mechanism in *C. formosanus* can be summarized as follows : a) Wood fragments are cut out and chewed by termites, and polysaccaride components, especially non-cryatalline region of cellulose, are partially decomposed during passing through the midgut by termite's enzymes. b) The fragments consisting of partially degraded polysaccarides and lignin are then ingested by two larger-sized protozoa, *Pseudotrichonympha grassii* and *Holomastigotoides hartmanni*, and the latter plays as a wood scavenger throughout the hindgut. c) *P. grassii* and *H. hartmanni* utilize large and low-molecular weight fractions of cellulose as nutrients, respectively, and lignin skelton is released as digestive residues. d) Protozoan fermentation products such as acetate are released into the hindgut fluid and absorbed by termites as nutritional sources. e) The smallest species in size, *Spirotrichonympha leidyi*, also absorb fermentative products of the other protozoan species as termites, and methanogenic bacteria in the bodies produce methane.

Biodegradation of wood fragments in the digestive tube of *Coptotermes formosanus* Shiraki (Isoptera : Rhinotermitidae), T. YOSHIMURA, Y. IMAMURA, K. TSUNODA and M. TAKAHASHI : *Holzforschung*, **49**(5), 385–388 (1995).

Wood fragments in the digestive tube of workers of *Coptotermes formosanus* Shiraki were observed using scanning electron microscope.

Wood fragments from the foregut did not show any degrading symptoms. On the other hand, diverse but superficial degrading symptoms were observed on the surface of the fragments from the posterior part of the midgut. In the posterior part of the hindgut, a little amount of wood fragments without degrading symptoms and many amorphous digestive residues were present. These results suggest that the major part of wood fragment is degraded in the hindgut, although a slight degdadation is caused by termite's enzymes in the midgut. Protozoan fauna in the hindgut probably contribute to this degradation.

Ingestion and decomposition of wood and cellulose by the protozoa in the hindgut of *Coptotermes formosanus* Shiraki (Isoptera : Rhinotermitidae) as evidenced by polarizing and transmission electron microscopy, T. YOSHIMURA, T. FUJINO, T. ITO, K. TSUNODA and M. TAKAHASHI : *Holzforschung*, **50**(2), 99–104 (1996).

Ingestion and decomposition of wood and cellulose by the three protozoa in the hindgut of *Coptotermes formosanus* Shiraki were investigated using polarizing microscopy and transmission electron microscopy (TEM).

Most of wood and cellulose fragments were ingested by the two larger protozoa,

Pseudotrichonympha grassii Koidzumi and *Holomastigotoides hartmanni* Koidzumi, but not by the smallest species, *Spirotrichonympha leidyi* Koidzumi. Little wood fragments were observed in the hindgut fluid.

TEM observations of wood fragments in the body of *P. grassii* and *H. hartmanni* clearly indicated that wood polysaccharides such as cellulose were completely decomposed to water-soluble materials by the protozoan enzymes, and that lignin residues were releaseed as a loose fibrous materials.

Wood consumption and survival of the subterranean termite, *Coptotermes gestroi* Wasmann using the Japanese standardized testing method and the modified wood block test in bottle, Y. SORNNUWAT, C. VONGKALUANG, T. YOSHIMURA, K. TSUNODA and M. TAKAHASHI: *Wood Res.*, **82**, 8–13 (1995).

Wood consumption and survival rate of the subterranean termite, *Coptotermes gestroi* Wasmann, which is the most economically destructive species in Thailand, were determined in laboratory according to the standardized testing method of the Japan Wood Preserving Association (JWPA) and the modified wood block test in bottle (MWBT). Wood blocks of *Pinus densiflora* Sieb. et Zucc., measuring 10 mm (*T*) × 10 mm (*R*) × 20 mm (*L*), were used as specimens to compare the feeding activity with that of *C. formosanus*, which was the most destructive species in Japan. At all group sizes (number of workers) tested, wood consumption per individual and survival rate in MWBT were greater than those in JWPA-test. At the smallest group size (150 workers), mean wood consumption per individual was counted 0.63 mg in MWBT, but it was only 0.24 mg in JWPA-test. Although it increased in JWPA-test at larger group size, it did not reach the equal level of MWBT even at the largest group size tested (400 workers). Data analysis revealed that size did not cause any significant effect on survival rate in both test methods. Taking account of the susceptibility to desiccation, MWBT, using glass bottle with moistened sand matrix, was considered suitable to *C. gestroi* for laboratory forced-feeding test. As for the group size, 250–300 workers in a bottle was recommended in the situation of limited supply of this species.

Natural resistance of seven commercial timbers used in building constructions in Thailand to subterranean termite, *Coptotermes gestroi* Wasmann, Y. SORNNUWAT, C. VONGKALUANG, T. YOSHIMURA, K. TSUNODA and M. TAKAHASHI: *Jpn. J. Environ. Entomol. Zool.*, **7**(3), 147–150 (1995).

On the seven commercial timbers tested, three timber species, *Anogeissus acuminata* Wall., *Chukrasia tabularis* Wight & Arn. and *Lagerstroemia floribunda* JACK. appeared to be "resistant" or "moderately resistant" against termite attack in both choice and no-choice tests. Meanwhile, the other four *Dipterocarpus* spp. were found to be "non-resistant" as well as the susceptible timber, *Hevea brasiliensis* Muell. Arg (rubber wood) and *Pinus densiflora* Sieb. et Zucc. (Japanese red pine). Termiticidal treatment is strongly recommended for

utilizing these *Dipterocarpus* species as building construction.

Survey and observation on damaged houses and causal termite species in Thailand, Y. SORNNUWAT, C. VONGKALUANG, M. TAKAHASHI, K. TSUNODA and T. YOSHIMURA: *Jpn. J. Environ. Entomol. Zool.*, **7**(4), 191–200 (1996).

Postal and personal surveys of the damage to construction caused by subterranean termites in Thailand were done in five regions of the country in 1992. Approximately 61.5% of survey houses throughout the country were infested by subterranean termites. Variation among infestation rate and regions might be more related to soil type than to climatic factors. House types and years after construction are other factors related to the infestation rate in houses (house type; wooden=mixture type>concrete or masonry, aged year; over 5 years>less than 5 years). Flooring, beams, joists, and sills are the most susceptible parts frequently infested by subterranean termites and should be given adequate treatment. Dusting with Paris green and spraying with chlorinated hydrocarbon insecticides (aldrin, dieldrin, chlordane, heptachlor, and DDT) are the most common practices as current countermeasure against infestation. *Coptotermes gestroi* Wasmann, which is the most important species attacking houses in both urban and rural areas, is widely distributing throughout the country.

Foraging territory of subterranean termites, *Coptotermes gestroi* Wasmann, Y. SORNNUWAT, C. VONGKALUANG, M. TAKAHASHI, K. TSUNODA and T. YOSHIMURA: *Jpp. J. Environ. Entomol. Zool.*, **7**(4), 201–210 (1996).

The foraging territory of the subterranean termite *Coptotermes gestroi* Wasmann in an urban area of Thailand was investigated by the mark-release-recapture method using Nile Blue A as a dye marker. We found that three-days' forced-feeding of filter paper stained with 0.05% Nile Blue A solution (w/w) was suitable for marking the termites; the day remained visible throughout the next 15 days with little toxicity to the termites. Foraging territories of three colonies were mostly found underground within the depth of 30 cm, and the highest foraging activity was observed at the depth of 15 cm below the soil surface. The maximum foraging distance was approximately 5.0 m from the first release station, and the soldier proportion was the highest in the subsurface foraging territory. Mean individual body weight of workers and soldiers ranged from 2.7–2.8±0.06–0.11 mg and 2.4–2.5± 0.07–0.09 mg (mean±SD), respectively.

Longevity of soil termiticides weathered for 3–4 years in Thailand under in situ observation and laboratory bioassay using *Coptotermes gestroi* Wasmann, Y. SORNNUWAT, C. VONGKALUANG, M. TAKAHASHI, K. TSUNODA and T. YOSHIMURA: *Mokuzai Gakkaishi*, **42**(5), 520–531 (1996).

Longevities of several soil termiticides against chlorinated hydrocarbons were evaluated

with field-exposure tests and laboratory bioassays of weathered termiticide-treated soils. Field-exposure tests were conducted at three test sites in Thailand with the ground stake test (GST) and the modified ground board test (MGBT). Residual anti-termite activity was assayed for tunneling activity according to the Japanese standardized method using the most economically important Thai termite species, *Coptotermes gestroi* Wasmann.

Because of the reduced anti-termite activity in the soil treated with chlorpyrifos after short-term weathering, an application of chlorpyrifos for termite control was considered useless for long-term protection in Thailand. Laboratory bioassay combined with field weathering was considered the most reliable method to determine the longevity of soil termiticides in a tropical country such as Thailand. Among the alternatives tested, permethrin (2.0%), alpha-cypermethrin (0.3%), and bifenthrin (0.1%) were promising considering their longevity. Concerning the field weathering procedure, the MGBT was considered preferable to the GST for better simulation of the slab-on-concrete structures of Thailand and its well-suitability against *C. gestroi*.

Physical and biological properties of albizzia waferboard modified with cross-linking agents, S. YUSUF, Y. IMAMURA, M. TAKAHASHI and K. MINATO : *The Int. Res. Group on Wood Preserv.*, Document No. IRG/WP/95-40043, pp. 13 (1995).

Chemically-modified low-density waferboards with cross-linking agents were produced using a fast-growing apecies of hardwood albizzia (*Paraserienthes falcata* Becker) as a raw materials and isocyanate resin as a glue adhesive. For the chemical modification, the vapor-phase formalization of the boards and the pad-dry-cure treatment of wafers with cross-linking agents were employed. The vapor-phase formalization was conducted for 5, 10 and 24 hours using tetraoxane as a source of formaldehyde, and the pad-dry-cure treatments with glutaraldehyde and ethyleneurea compound (DMDHEU) were made after impregnation of their 5 and 10% aqueous solutions of each chemical. Sulfur dioxide was used as a catalyst in both treatments.

About 70% of antiswelling efficiency (ASE) was gained in all treated boards irrespective of reaction time or solution concentration. All treated boards were very stable to water soaking even in the 2-hour boiling on thickness swelling as well as linear expansion. Laboratory tests with brown-rot and white-rot fungi revealed that decay was completely suppressed in formaldehyde-treated boards, and small losses in weight were counted in other treated boards. All treated boards were also effective in resisting to the attack by the destructive termite *Coptotermes formosanus*.

Weathering properties of chemically modified wood with some cross-linking agents and its decay resistance after weathering, S. YUSUF, Y. IMAMURA, M. TAKAHASHI and K. MINATO : *Mokuzai Gakkaishi*, **41**(8), 785–793 (1995).

Weathering propecties of laminated veneer lumber (LVL) of radiata pine (*Pinus radiata*

D. Don) treated with cross-linking agents such as formaldehyde, glyoxal, glutaraldehyde, and dimethylol dihydroxyethylene urea (DMDHEU) were investigated in correlation with surface-color changes, extents of checking, and biological resistances after weathering.

Color stability of the treated woods were observed after natural-weathering, and Delta E* as an index of color change of radiata pine LVLs was the smallest in those with DMDHEU treatment after 24 weeks of outdoor exposure. In artificial weathering tests combining light-irradiation and water spray, all treated LVLs with finishes exhibited small Delta E* values of less than half of the control samples for the entire 720 hours. In contrast, when treated samples were unfinished, they showed larger Delta E* than those of the control samples. Although surface checks in all finished samples were less than those of unfinished samples, no significant difference was seen in overall checking resistance among any treatments with cross-linking agents. The anatomical features of the surface appearances were confirmed by SEM observations, and it was found that the occurrences of large surface checks were limited for the treated woods. After exposure to weathering, decay resistances of radiata pine LVLs still were efficient with all treatments, and the formaldehyde treatment had the best performance among these cross-linking agents.

Termite trail-following substances produced by brown-rot fungi, W. OHMURA, M. TOKORO, K. TSUNODA, T. YOSHIMURA and M. TAKAHASHI: *Material und Organismen*, **29**(2), 133–146 (1995).

Chemical substances prepared from wood decayed by *Serpula lacrymans* and mycelia of *Gloeophyllum trabeum* were used for the determination of their termite trail-following actrivities by bioassay.

The trail-following activity of *G. trabeum* mycelia was 10^5 times as high as that of *S. lacrymans* decayed wood, although further isolations resulted in the decrease of activity.

GC-MS-SIM analysis showed that *G. trabeum* mycelia peaks corresponded with DTE-OH that was involved in termite trail-following activity.

Trail-following active compound in *S. lacrymans* was not DTE-OH. It is possibly a type of alcohol, although to confirm this further work is needed.

Observation of feeding behavior of termite using CCD camera and its relation to the generation of acoustic emission, Y. FUJII, Y. IMAMURA and T. YOSHIMURA: *Wood Res.*, **82**, 47–53 (1995).

The feeding behavior of a worker of *Coptotermes formosanus* Shiraki was observed with CCD camera under AE monitering. Two types of feeding behavior, biting and nibbling using the mandible, were observed. AEs were detected only when the termites bited or nibbled at the wood surface.

Termite likes steamed larch wood, S. DOI, M. KUBOTA, M. TAKAHASHI, T.

YOSHIMURA and A. ADACHI : *The Int. Res. Group on Wood Preserv.*, Document No. IRG/WP/95-10113, pp. 6 (1995).

Steamed wood of Japanese larch (*Larix leptolepis* (Sieb. et Zucc.) Gord.) was preferably attacked by termites. Steam treatments have often been applied to Japanese larch wood for improving its penetrability or color. For preventing termite attack on steamed timber, we have to elucidate why termite likes it.

Choice tests with *Coptotermes formosanus* Shiraki were conducted using larch boards steamed for 30–240 min at 160–170°C. Weight losses due to termite attack were very small in non-steamed boards white they were very large in steamed boards. Steamed samples extracted with hot water were not attacked by termite. This means that increased palatability to steamed samples was affected by some components of hot water extracts which were possibly produced by steam treatments.

Forced tests were also carried out by exposing the steamed wood samples to *C. formosanus* in an acrylic cylinder with plaster bottom. The overall results suggested that steam treatments degraded and/or removed some larch wood constituents which suppress termite attack.

Dynamic mechanical properties of thermosetting resin adhesives I. Phenolic resin, K. UMEMURA, S. KAWAI, Y. MIZUNO and H. SASAKI : *Mokuzai Gakkaishi (J. Jpn. Wood Res. Soc.)*, **41**(9), 820–827 (1995) (in Japanese with English Summary).

The effects of preheating (120 or 160°C) treatments on the dynamic thermomechanical properties of an aqueous phenol-formaldehyde (PF) resol resin was studied by using a dynamic mechanical analysis (DMA). The results and conclusion are summarized as follows : It appeared that the untreated liquid state of PF resin has a distinct gel point with sudden changes of storage modulus (E'), loss modulus (E''), and tan δ, whereas, vacuum dried PF resin exhibited different E', E'', and tan δ curves during measurements at elevated temperatures. As the preheating time was prolonged, the initial (20°C) E' generally increased with a drop of the peak in tan δ but independent of the preheating temperature. The gel point of the resin preheated for a few minutes at 120°C appeared lower than that of resin preheated for the same times at 160°C. These results suggested that the curing reactions of PF resin were dependent on heating temperature, and the result of the partially cured resin preheated for few minutes at 120°C was unstable at an increasing temperature. It also was observed that the resin preheated for 5 min at 160°C cured completely with the disappearance of the tan δ peak, whereas resin preheated at 120°C cured incompletely with a tan δ peak independent of the preheating time. In addition, the authors have proposed a method of determining the degree of cure for PF resin in mechanical aspects. The method is based on the change of the E' of preheated resin during DMA measurements. Compared with the conventional methods, such as methanol extraction, this method is affected by a

solvent including resin and is expressed seemingly as a mechanical cure.

Curing behavior of wood adhesives under high-pressure steam I. Phenolic resin, K. UMEMURA, S. KAWAI, R. NISHIOKA, Y. MIZUNO and H. SASAKI: *Mokuzai Gakkaishi (J. Jpn. Wood Res. Soc.)*, **41**(9), 828–836 (1995).

The curing behavior of aqueous phenol formaldehyde (PF) resol resin under steam-injection heating was investigated using several analytical methods.

The results were as follows: (1) The curing reaction of 2-hydroxybenzyl alcohol as a model compound, under steam-injection at 160°C was followed by rapid formation and then breakdown of the ether group. (2) By steam-injection at the higher temperature of 160°C, it was revealed that the PF resin immediately cured to some degree in a few minutes; after that, it did not reach a full cure. The resin also accompanied the rapid disappearance of the ether structure. In the resin heated by steam-injection, free water hindered the curing reaction, and by-products were contained. At the lower temperature of 120°C, the curing reaction of the resin was somewhat delayed compared to that heated under conventional hot-platen heating.

Manufacture and properties of composite fiberboard II. Fabrication of board manufacturing apparatus and properties of bamboo/wood composite fiberboard, M. ZHANG, S. KAWAI, H. SASAKI, T. YAMAWAKI, Y. YOSHIDA and M. KASHIHARA: *Mokuzai Gakkaishi (J. Jpn. Wood Res. Soc.)*, **41**(10), 903–910 (1995).

Bamboo/wood composite fiverboards were manufactured using bamboo and wood fibers as raw materials at various fiber mixing ratios. An apparatus for drying fiber with an adhesive blending device was set up, and an apparatus for forming fiber mats also was fabricated for this experiment.

A carding machine was used to mix the bamboo and wood fibers. The fiber mixing ratios of bamboo to wood (B/W) were 1/0, 3/1, 1/1, 1/3 and 0/1, and the target board specific gravities were 0.60 and 0.80. The amount of isocyanate resin added was 10% of the oven-dry weights of fibers.

The moduli of rupture (MOR) and elasticity (MOE) in both dry and wet conditions, the internal bond strength (IB), the thickness swelling (TS), and the linear expansion (LE) were tested for and analyzed.

Increasing the mixing ratio of bamboo fiber improved the MOR, the MOE retention ratio, and the linear expansion of boards after boiling.

Manufacturing compressed laminated veneer lumber made from sugi rotary-cut veneer used for timber construction fasteners (I) Properties of compressed veneer resin-impregnated by water-soluble phenol-formaldehyde resin, K. NAKATA, H. SUGIMOTO, H. KAIMOTO and S. KAWAI: *Bull. Nara Pref. Expt. Sta.*, No. **25**, 22–28 (1995).

Resin-impregnated rotary-cut veneers of Japanese cedar (*Cryptomeria japonica* D. DON) by using a low molecular weight phenol-formaldehyde resin (PF) were pressed into compressed veneers of different densities by hot pressing. The impregnating ability of veneers, the dimensional stability and the bending properties of compressed veneers were determined. The results were as follows:

1) The weight percent gains *(WPG)* of the veneers under a normal pressure increased both with increasing the logarithms of soaking time and with increasing PF concentrations.

2) Logs treated under the three conditions, i.e., soaking under normal pressure, heating at 60°C for 24 hours and boiling for 24 hours, were rotary cut, *WPG* of veneers boiled were the smallest of those.

3) The resin impregnation made great improvement in the dimensional stability of the compressed veneers. The thickness swelling after an accelerated aging test in compressed veneers was under 7% at above 25% *WPG*.

4) Modulus of elasticity and modulus of rupture of compressed veneers increased with increasing densities, and those which densities were above 1.2 g/cm^3 reached 30Gpa and 250MPa, respectively. But, both those of compressed veneers which were impregnated by 30% concentration liquid, had a tendency of decrease.

Manufacturing compressed laminated veneer lumber made from sugi rotary-cut veneer used for timber construction fasteners (II) Compressibility of non-rotary-cut veneer using hot-press, K. NAKATA, H. SUGIMOTO, H. KAIMOTO and S. KAWAI: *Bull. Nara Pref. Expt. Sta.*, No. **25**, 29–36 (1995) (in Japanese with English Summary).

Rotary-cut veneers of Japanese cedar (*Cryptomeria japonica* D. DON) with initial moisture contents *(MC)* of 12, 22 and 27% were laminated to 2 or 9 layers without adhesives, and those were pressed into the 1/3 of the initial thickness using a hot-press. Compressive stress during hot-pressing, changes in *MC* and thickness before and after hot-pressing were determined. The results were as follows:

1) Compressive stress decreased with increasing initial *MC* and the temperature of the hot-pressing, that was remarkable at the region looking like tableland where the compression ratio was nearly 10–50%.

2) The final *MC* of press-dried veneers decreased with increasing the product of temperature and time at veneers in case of platen temperatures over 90°C. The thickness of hot-pressed veneers increased with increasing final *MC*, due to partial recovery of compression set. And it varied more at higher initial *MC*.

3) The thickness variation of veneers with high initial *MC* decreased when the pressing time was longer. The final *MC* and the variation of the thickness decreased with the breathes in three times during pressing. At the production of laminated veneer lumber of 9 plies with high initial *MC*, it was estimated that these breathes were effective in reducing a

final *MC* at the central layers.

Manufacturing of bamboo-cement composites I. Hydration characteristics of bamboo-cement mixtures, L. MA, Y. KUROKI, D. A. EUSEBIO, W. NAGADOMI, S. KAWAI and H. SASAKI: *Mokuzai Gakkaishi (J. Jpn. Wood Res. Soc.)*, **42**(1), 34–42 (1996) (in Japanese with English Summary).

The hydration temperature and hardness of a mixture of bamboo (*Phyllostachys heterocycla* Mitf. *var. pubescens* Ohwi) powder and cement were examined. The inhibitory index and compatibility factor also were determined. The inhibitory characteristics of the different parts of bamboo to cement were evaluated. The improved effects on the compatibility of bamboo treated by roll-crushing, extraction and molding to cement were examined. The results were as follows: 1) The compatibility of untreated bamboo to cement was not good; 2) Although there were still inhibitory materials to the hydration reaction in the roll-crushed bamboo, the hardness of the cured paste was promoted; 3) Cold-water, hot-water, and a 1% NaOH solution, which were used for extracting the bamboo, can moderate the inhibitory effects in the hydration reaction of the bamboo-cement mixture; 4) The treatment of molding and fermenting also can moderate and even climinate the inhibitory effect in the hydration reaction of the bamboo-cement mixture.

Curing behavior of wood adhesives under high-pressure steam II. Urea resin, K. UMEMURA, S. KAWAI, Y. MIZUNO and H. SASAKI: *Mokuzai Gakkaishi (J. Jpn. Wood Res. Soc.)*, **42**(1), 65–73 (1996).

The curing behavior of urea formaldehyde (UF) resin under steam-injection heating was studied using a fourier transform infrared spectrometer (FT-IR) and a solvent extraction test. In addition, hot-platen curing and steam-injection curing of the resin were compared with each other. The results were as follows: (1) In the reaction of 1, 3-dimethylolurea as a model compound under steam-injection heating, the formations of linear or cyclic tertiary amide and cyclic ether were observed. These were slightly observed in hot-platen heating. (2) In the reaction of UF resin under steam-injection heating, marked chemical changes took place, which were not observed in the hot-platen heating. Furthermore, the cyclic ether formed by the curing reaction was considered to be relatively stable even under steam-injection heating. (3) Compared with hot-platen heating, UF resin react more quickly and increase warm water insoluble matter in steam-injection heating. Afterwards, however, it was shown that the reaction of UF resin apparently came to equilibrium at lower temperature of 120°C, and the hydrolysis proceeded at higher temperature of 160°C.

Bending fatique properties of medium density fiberboard floors, Q. WANG, S. TAKINO, S. KAWAI, M. IKEDA and H. SASAKI: *Mokuzai Kogyo (Wood Industry)*, **51**(4), 157–161

(1996) (in Japanese with English Summary).

To evaluate applicability of melamine type (M-type) medium density fiberboard (MDF) to floors, bending fatigue properties were investigated.

The following test pieces were prepared for a fatigue test in repeated bending load.

1. Small test pieces of solid MDF (size: 450×50×12 mm)

2. Joisted floor models made of solid MDF, decorative veneer overlayed MDF and commercial plywood floor respectively (size: 600×606×12 mm)

The results obtained are as follows.

1) The fatigue strength of small test pieces at 10^6 cycles were approximately 52% (279 kgf/cm^2) and 42% (225 kgf/cm^2) of the static bending strength for an air-dry and a water soaking conditions respectively.

2) There was no fatigue fracture in solid MDF of joisted floor models after 10^6 cycles of 150 kgf bending load for both an air-dry and a water soaking conditions. The retention of bending strength was 405 kgf/cm^2 and maximum deflection by repeated bending load was 2.28 mm.

3) There was no fatigue fracture in decorative veneer overlayed MDF of joisted floor models after 10^6 cycles of 100kgf and 150 kgf bending load for both an air-dry and a water soaking condition. Deflection increased in proportion to times of repeated bending load. Similar behaivior was observed as to joisted floor models using commercial plywood floors.

4) It was found that M-type MDF can be applicable to floors which are subjected to repeated bending load such as footing for a long service time.

Dynamic mechanical properties of thermosetting resin adhesives II. Urea resin, K. UMEMURA, S. KAWAI, Y. MIZUNO and H. SASAKI: *Mokuzai Gakkaishi (J. Jpn. Wood Res. Soc.)*, **42**(5), 489–496 (1996).

The mechanical curing process of urea formaldehyde (UF) resin treated under several conditions was studied using dynamic mechanical analysis (DMA). The following results were obtained: (1) the curing process of liquid UF resin with catalyst proceeds through a two-stage curing process with increasing oven temperature. However, the curing process of UF resin was greatly affected by the presence or absence of water and a catalyst. (2) The cured states of preheated resins by hot-platen heating and steam-injection heating were observed. In addition, a mechanical curing index was calculated to reveal the mechanical curing behaviors under each heating condition. It has become apparent that the curing of UF resin proceeds with increasing heating time under hot-platen heating. However, it was found that UF resin immediately cured to some degree, and then dilution and/or decomposition took place under steam-injection heating.

Manufacture of wood composites using lignocellulosic materials and their properties, M. ZHANG and S. KAWAI: Proceedings of '96 MRS-J Symposium D "The

Latest Progress of New Plant Material", p. 113–116, 1996. 5. 22–24, Chiba, Japan (in Japanese with English Summary).

Fibers and strands from wood and lignocellusosic materials such as bamboo, jute, bagasse, and grass were used to manufacture various types of composite boards, namely: Jute/wood composite fiberboards (JF-WF) made from mixing jute fiber (JF) and wood fiber (WF), bamboo/wood composite fiberboards (BF-WF) made from mixing bamboo fiber (BF) and WF at various fiber mixing ratios. Three-layered composite boards (BS/WF/BF) with BF as face materials and WF as core material, and three-layered composite boards (BS/WF/BF) with bamboo strands (BS) and WF as face and core materials, respectively. Conventional hot pressing method was used using isocyanate resin (IC), urea formaldehyde (UF), and urea-melamine co-condensate resin (UMF) as adhesives.

Bagasse particleboards were also manufactured by using steam-injection pressing to improve the dimensional stabilities of boards.

Moduli of rupture (MOR) and elasticity (MOE) of JF-WF boards increased with increasing JF content. Dimensional stability after boiling of BF-WF boards improved greatly with an increase in the BF content. No significant change in the linear expansion (LE) of boards was observed even at lower BF content (for example, 25%). The thickness swelling (TS) of BF/WF/BF boards was only 5%. The MOR and MOE of BS/WF/BS boards were higher compared to those of plywood and other composite boards. Steam injection pressed bagasse particleboards have very good dimensional stabilities at water soaking and boiling test, and moisture absorption test. The MOR of IC-bonded grass particleboards was almost the same compared to wood particleboards.